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ENVIRONMENTAL IMPACT ASSESSMENT OF JAMUNA MULTIPURPOSE BRIDGE PROJECT

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ABSTRACT

Jamuna Multipurpose Bridge Project (JMBP) constructed over the river Jamuna connecting the eastern and north-western parts of the country was the largest infrastructure development project in Bangladesh. The northern intake of the Dhaleswari river, a tributary of the Jamuna river was closed to accommodate the bridge end facilities and prevent possible over flanking of the Jamuna river, which affected the hydraulic regime of the Dhaleswari basin. The river training works and bridge piers constricted the river flow resulting back and tail water effects. The changes in water regime and acquisition of land inflicted major environmental and social impacts. The wildlife in the area was also disturbed and dislocated during construction of the bridge. A number of studies was conducted to assess the environmental and social impacts of construction of the bridge. This paper describes a summary of the environmental and social impacts of this largest development project of the country.

Keywords: *Jamuna Multipurpose Bridge Project, River Training, Environmental and Social Impacts*

1.0 INTRODUCTION

The river Jamuna is a natural physical barrier between the northwestern and eastern parts of Bangladesh. This physical barrier was seen as an impediment to economic development and social unity. As a result, there had long been a national desire to establish a permanent link between the east and the north-west. The construction of Jamuna Multipurpose Bridge was proposed to establish this permanent link between the two parts of the country. The bridge provided for the transfer across the Jamuna river of road and rail traffic and energy. The energy transfer to the west was achieved by means of a second electricity interconnector and a gas pipeline over the bridge.

This was the longest bridge and largest infrastructure development project in Bangladesh. The major components of the Jamuna Multipurpose Bridge Project (JMBP) were as follows:

- The main bridge, a 4800 m long multispan box girder type structure with concrete deck on 90 m long steel tubular piles.
- The bridge end facilities, about 6000 m in total length built on reclaimed land within the Jamuna floodplain at both ends of the bridge.
- The approach roads, about 25 km in total length, built on both sides of the bridge to connect the existing road network of the country.
- The river training works.

All these involved massive activities having both positive and negative effects on the components of the natural environment. In order to minimize adverse effects it became essential to identify all possible environmental impacts of the project and determine the most significant adverse effects and their possible remedies. This paper presents the major environmental impacts of this largest infrastructure development project in Bangladesh.

2.0 ENVIRONMENTAL IMPACTS OF JMBP

2.1 The Environmental Parameters

The environmental impact area of the JMBP was defined as all areas where physico-chemical, ecological, and socio-economic changes were expected due to construction of the bridge. The major environmental components and parameters identified by Initial Environmental Evaluation (IEE) to be impacted by the construction of the bridge are listed in Figure 1.

THE ENVIRONMENT

Physical & Chemical

Jamuna River
- Back &Tail Water Effects
- Erosion & Accretion
- Embankment stability

Dhaleswari & Its Basin
- Hydrology
- Groundwater recharge

Pollution
- Water pollution
- Air pollution
- Noise pollution

Dredging

Ecological

Terrestrial & Aquatic
- Fisheries
- Wildlife
- Vegetation
- Afforestation

Human Interest

Agriculture
- Agricultural practice
- Crop diversity
- Crop production

Socio-economic
- Land acquisition
- Resettlement
- Urbanization
- Tourism
- Employment
- Boat navigation

Figure 1: Total Environmental Impact of JMBP

2.1.1 Physico-Chemical Impacts

The Jamuna River:

The construction Jamuna Multipurpose Bridge induced backwater effect, erosion and scours, siltation and accretion in the river and exerted some influence on the stability of the banks and flood control embankment.

Mathematical Simulation study showed that the backwater effect would be extended to about 50 km upstream and tail water effect to 10 km downstream due to flow constriction at bridge site. It was estimated that the maximum backwater effect would be less than 0.1 m during average flood. During high floods of 10 yrs, 50 yrs, and 100 yrs. return periods, the estimated backwater effects would be 0.2 m, 0.25 m and 0.30 m respectively. The backwater effect will cause additional submergence of char lands located within 50 km upstream of the bridge. The probability of Jamuna left and right embankments failure will be doubled due to backwater affect. The present high flood level of 100 years will occur at 50 years return period. Similarly the present 1 in 50 years flood level will be exceeded every 25 years. However, the river training work provided additional protection to bank and flood embankments over a distance of about 10-km at each bank. The project related additional scours would be 3m due to river constriction and 4 m at bridge piers as local scour. The physical and mathematical model tests confirmed that dynamic equilibrium between accretion and erosion will exist and braiding nature of the river will remain undisturbed due to construction of the bridge. However, some additional erosion and siltation can be expected in the river as well as in the flood plains due to construction of river training works.

Dhaleswari River and Its Basin:

The feasibility study of the project envisaged the complete closure of the north intake of Dhaleswari river by the approach road at the east end of the bridge. The north intake and the minor spill channels which fed the Dhaleswari contributed about 45-50 percent of the total flow in the mid-Dhaleswari.

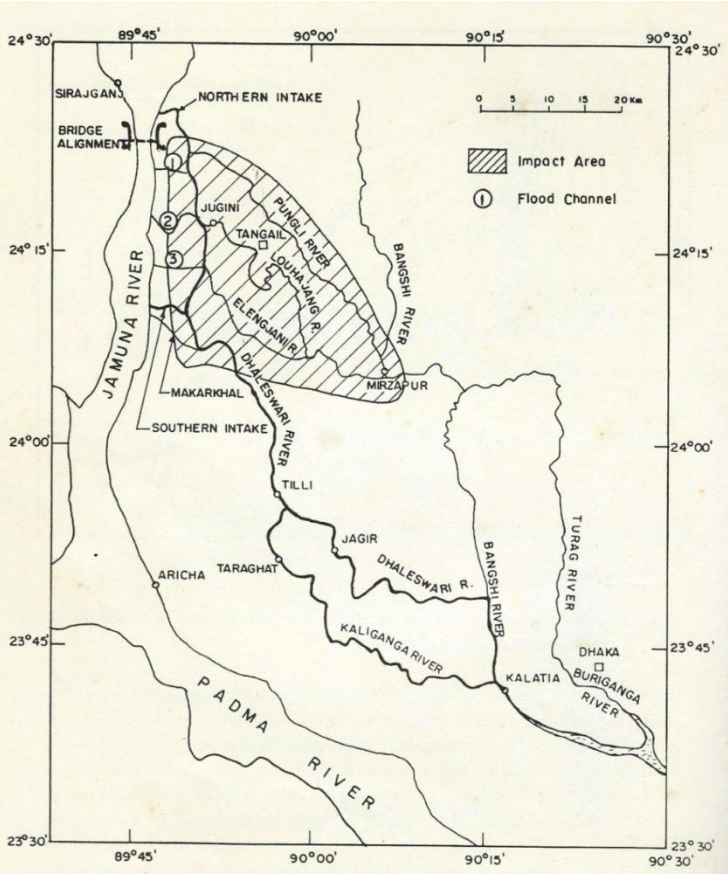


Figure 2: The Dhaleswari basin

The study showed that the maximum flow reduction in the middle reach of the Dhaleswari due to closure of the north intake would be about 35 percent. This would exert a significant impact on the upper Dhaleswari basin and a relatively lower impact on the middle Dhaleswari basin. According to GHK/MRM (1992) model study, the Pungli river would have its annual flow reduced by 53 percent. It was also estimated that the flow in the Lauhajang would drop from 4 billiom cu.m/yr. to 3 billion cu.m./yr. of the total 136 billion cu.m. annual flow from the

Jamuna to Dhaleswai and other rivers in the impact area. A reduction of about 15 billion cu.m./yr. on average would occur as a result of the closure, affecting about 660 sq.km. or 19% of Tangail district. The area most significantly influenced by the reduction of flow from the Jamuna in northern part of the Dhaleswari basin is shown in figure 2.

The closure of the north intake would result in the cutoff of 29 billion cu.m./yr. of flow in the Dhaleswari basin. However, as a result, the flow through the first two flood channels in the south of the bridge would also be increased from 6 billion cu.m/yr. to 16 billion cu.m./yr. In addition the flow through southern intake would also increase from 79 billion cu.m/yr. to 82 billiom cu.m./yr. The changes in the annual discharge of the intake channels from Jamuna river to Dhaleswari basin and annual discharge of the rivers in the Dhaleswari Basin are shown in Figure 3 and Figure 4 respectively.

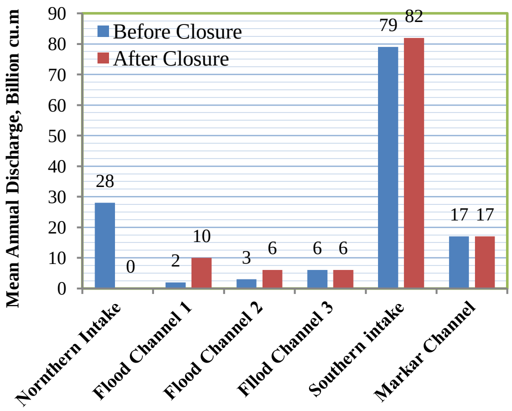


Figure 3: Changes in the annual discharge of the intake channels from Jamuna river into Dhaleswari Basin

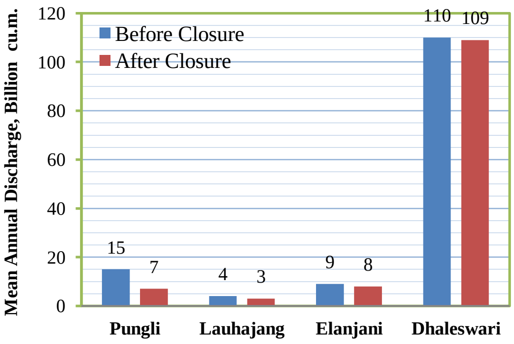


Figure 4: Changes in the flow of rivers in the Dhaleswari basin

The mathematical simulation of Dhaleswari flow shows that the maximum flood levels in the upper basin would be reduced by 0.25 m to 0.50 m and in the middle basin by less than 0.10m. However, the water level reduction in the pre-and post-monsoon periods would be most significant i.e. upto 1.25 m reduction in the upper Dhaleswari basin and 0.6 m reduction in the middle basin.

Lower water and inundation levels in the Dhaleswari basin would naturally lead to a decrease of potential recharge. However, the MPO ground water studies in the area showed that the actual recharge was less than the potential recharge. Considering the rate of ground water utilization, reduction of potential recharge by about 10-30 percent would not affect the total replenishment of ground water in the area. However, the situation was likely to have adverse impact on large scale ground water development in the area.

Disruption of Drainage:

In absence of drainage structures in the approach road embankment and guide bunds in the flood plain, natural drainage and runoff in the upstream of bridge site would be severely disrupted. The area affected was about 4200 ha, of which 3250 ha was cultivable land. The number of affected households was approximately 1600. The stagnant water in this area was likely to be polluted by domestic waste disposal, washing and jute retting.

2.1.2 Ecological Impacts

Fisheries:

The closure of the northern intake of the Dhaleswari river would result in the direct disruption of the movement of fertilized fish eggs, hatchlings, fry and fingerlings from Jamuna into rivers, flood plains and beels in the impact area. The reduced flood in the Dhaleswari basin would exert an impact on the migration, reproduction and growth of fish in the rivers, flood-plains, canals, and beels in the area. The estimates based on hydrological modeling showed that the flood plain area in the Dhaleswari basin would be reduced from about 66,000 ha to 55,000 and the beel area would be reduced from 2,090 ha to about1,740 ha due to closure of the norththern intake of Dhaleswari basin (Table 1). The flow reduction in the Pungli and Lauhajang rivers would be about 53% and 25% respectively GHK/MRM (1992). The fish production loss was estimated using FAP-20 and Department of Fisheries (DoF) fish production data (Euroconsultant and Others, 1993, DoF, 1987-88). The total loss of fish production include 100% loss of fish production in the reduced areas of flood plain and beels and a partial reductions were assumed in areas depending on the flow reduction and delinking of the areas to rivers which prevents the natural migration of river fish hatchlings, fry and fingerlings. The 55,000 ha of flood plains under reduced flooding has been divided into 5 equal segments assuming declining fish losses from 50% in the north to 5% in the south. In addition 53% loss in the Pungli river and 25% loss in the Lauhajang river were estimated due to loss of flow. The changes in turbidity, silting pattern, current, and physico-chemical conditions may result in spawning failure, changes in species diversity, and shifting of spawning and migration grounds.

Table 1: Growth of fish production in different water sources

Fish Habitat	Rate of Fish Production	Loss of water & Production	Area/Length	Production loss, Ton
Flood plain	76 kg/ha	100% (dried)	11,000 ha	195
	76 kg/ha	50%	11,000 ha	97
	76 kg/ha	25%	11,000 ha	49
	76 kg/ha	15%	11,000 ha	29
	76 kg/ha	10%	11,000 ha	20
	76 kg/ha	5%	11,000 ha	10
Beels	76 kg/ha	100% (dry up)	350 ha	27
	76 kg/ha	25%	1740 ha	33
Pungli river	720 kg/km	53%	60 km	21
Luhajag river	720 kg/km	25%	56 km	11
Total				492

In addition to capture fishery, there was a carp seed, spawn and fry collection industry in the area. The collection of carp spawn was important because fresh water aquaculture in closed water bodies was largely dependent on the supply of captured fry and fingerlings. It was observed that 4 out of 15 seed collection centers in the area lied in the JMBP impact area (ISPAN, 1993). An estimate showed that on average 50 kg of spawn and fry was collected in the impact area per year (RPT-NEDECO-BCL, 1989). Although the seasonal up and down migration of fishes in the Jamuna would not be impaired, the lateral migration would be affected by the construction. It was also estimated that the reduction of spawn fry fish collection in the Dhakeswari-Kaliganga river system would result in the loss of 35 tons/year of fish.

Wildlife:

A comprehensive inventory of wildlife in the impact area was prepared under the wildlife study project of JMBA (Husain, 1990-91). Total 193 species of wildlife found in the area included 9 species of mammals, 169 species of birds, 9 species of reptiles and 6 species of amphibians. Out of 169 species of birds, 50 were winter migratory and 119 were resident species. Five ducks and seventeen waders recorded in the Jamuna and Dhaleswari rivers were mainly migratory and only two species from each group were resident and were adapted to the environment. The wild life in the impact area was composed of predators, scavengers, pest and commercially important species. The threatened and endangered species of wildlife in the area as enlisted in the National Conservation Strategy of Bangladesh (MoEF-IUCN, 1991) were delineated. These included 1 mammalia, 6 aves, 2 reptalia and 1 amphibia of which 3 wildlife species were endangered and 7 were threatened.

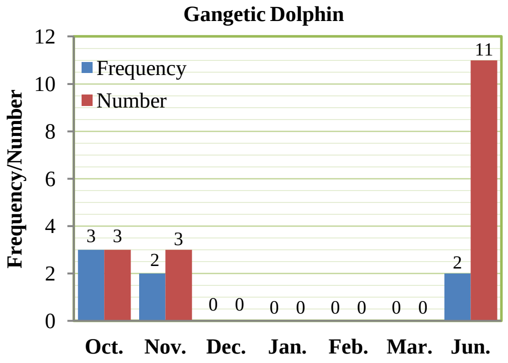
The construction of the bridge might cause temporary and permanent disruption of wild life in the area. As described earlier, the construction would bring about a major hydrological changes in the area affecting the ecological conditions. Although subsequent impacts on wildlife were expected to be both positive and negative in nature, their magnitudes were expected to be low to moderate. The wildlife in the Dhaleswari basin except few beels, was adapted to agro-ecosystem subjected to human intervention. Increase in the dry areas might provide improved habitat and ease the pressure on terrestrial wildlife. Wild birds might be attracted to stay longer in the area in view of increased food supply due to change in cropping pattern and increased terrestrial rest areas. Reduced floods might affect aquatic fauna and subsequently the wildlife dependent of aquatic fauna for food. The bushes and trees in homestead within the right-of-way used by birds for shelter and breeding would be destroyed. Dredging and construction activities would have impact on dolphin and migration of fishes. The bridge across the river would be an obstruction in migration route of birds along the river.

Dredging along the River Training Works (RTW) and bridge alignment destroyed some char lands. These chars were feeding ground of quite a few species of birds. The “Kansh” jungles growing naturally on the chars offer important shelter and breeding grounds for birds, specially for resident spotbill or Grey Duck (*Anas poecilorhyncha*). Other birds such as Small Partincole (*Gladiola lacteal*) use these jungles in March for breeding, whereas, a small number of Warbles nests in the "Kansh” jungles in November. The frequency and number of four species used for monitoring are presented in Figure 5.

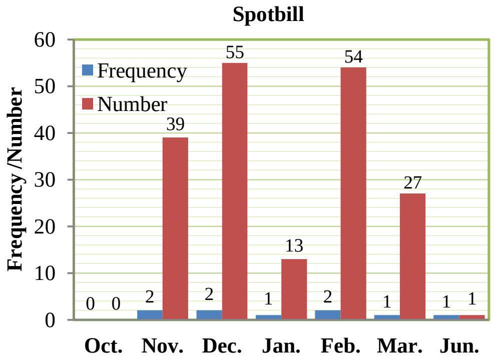
Jungles, Bushes and Trees:

No significant natural vegetation, forest or other natural resources of environmental concern were present in the area. Construction of embankment and approach roads destroyed some human settlements including planted trees, bushes and jungles. However, the approach roads, embankment, bridge end facilities and huge land recovered from the river provided enough space for plantation, horticulture and creating artificial forest.

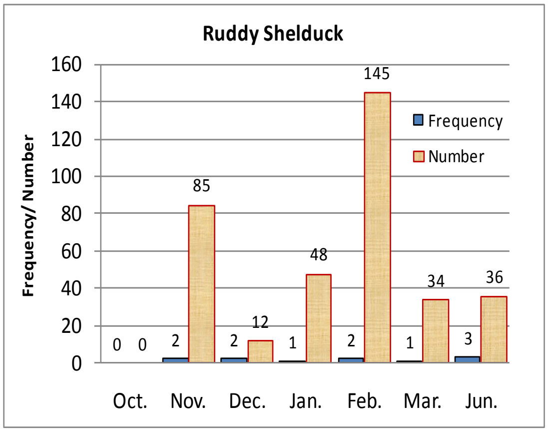
The transport of gas to northwest of the country zone will save estimated 250,000 tons of fuel wood, which will help conservation of scarce forest resources in this zone.



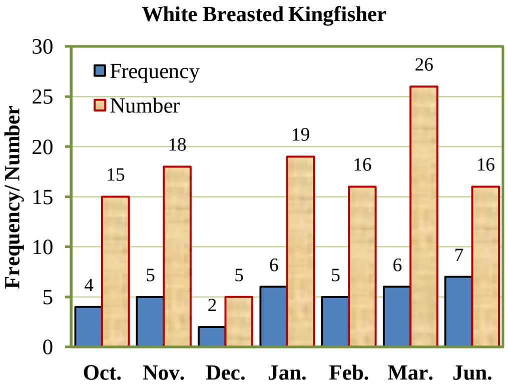
(a) Frequency and number of Gangetic Dolphin



(b) Frequency and number of Spotbil (Grey Duck)



(c) Frequency and number of Ruddy Shelduck (Chakha-Chakhi)



(d) Frequency and distribution of White–breasted Kingfisher

Figure 5: The frequency and number of four species used for monitoring

2.1.3 Human Interest

Disruption of Communication:

The JMBP would have some influence on road transport and navigation on the river Jamuna and Dhalelswari. Navigation on the upper Dhaleswari river would be adversely affected by the closure of the north intake. The country boats would not be able to enter into the Dhaleswari through the north intake which was navigable for a period of about 3 months. A study showed that 359 country boats carrying 1 to 3 tons of good plied the stretch from the Jamuna through northern intake channel into Dhaleswari and Pungli to Elengjani. The closure of the northern intake meant that the boats were to make a detour of 60 km when using the southern intake channel. The navigable period in the northern part of the Dhaleswari river would be reduced to about 1.5 months. The overall tonnage transport would be in the order of 21,200 tons during 3 months period and the related additional transport cost would be in the order of Tk. 4 to 6 million per year. The new approach roads would cross several other drainage channels outside the flood plain. Bridges on these channels would be constructed keeping ample clearance for free plying of small country boats.

The analysis of the river channels in the Jamuna that occurred during last 20 years showed that a minimum clear channel width of 170 m would always be available to meet the requirements for "A" class waterways (RPT-NEDECO-BCL, 1989). During construction of the Jamuna Bridge, additional traffic on the road from Dhaka to the bridge would be generated but these would neither be different from the conventional traffic using the route nor hamper the normal traffic flow.

Agriculture:

Agricultural activities in the area acquired for construction purposes were permanently disrupted and in some areas in close vicinity of the construction sites agricultural activities were temporarily disrupted. Changes in water regime due the bridge project were likely to exert the major impact on agricultural practices and production. The impact due to closure of the northern intake would be extended over about 53,424 ha agricultural land in the upper Dhaleswari basin. About 15,114 ha of MHL2 (F1) and ML (F2) & L (F3) lands will be converted to 11,144 ha HL (F 0) and 3,970 ha MHL1(F 0) lands as shown in Table 2, which would increase productivity through increased cropping intensity and changes in cropping pattern.

In the upper and middle Dhaleswari Basin the cropping patterns were likely to change from low yield to high yield varieties as a result of flood reduction. The reduction in flood depth would lead to reduction in crop losses and increase in the average yield. The incremental rice production in the upper Dhaleswari basin due to change in the land type and cropping pattern induced by the reduction in flood is shown in Table 3.

Table 2: Changes in agricultural land type in the impact area

Land Type (SRDI Classification)	**Flooding Depth, cm**	**Land Type MPO Classification**	**Estimated Area, ha**		**Change in Area, ha**
			Before Closure	**After Closure**	
High Land (HL)	0	F0	3,945	15,089	(+)11,144
Medium High Land (MHL-1)	0 - 30		5,774	9,744	(+) 3,970
Medium high Land (MHL-2)	30 - 90	F1	22,578	15,946	(-) 6,632
Medium Low Land (ML)	90 - 180	F2	17,879	10,836	(-) 7,043
Low Land (L)	180 - 300	F3	3,248	1,809	(-) 1,439
Total Cropped Land			53,424	53,424	0

It may be observed that about 10,276 tons of additional rice will be produced in the upper Dhaleswari basin area. There was a potential to produce additional 5,670 tons of rice in 162,000 ha of middle Dhaleswari, if the change in cropping pattern was intensively promoted with supply of adequate inputs. The loss of rice production in 1,156 ha of agricultural land acquired for the project was estimated as 2,192 tons at an average production rate of 1896 kg/ha of agricultural land. Production of jute was also expected to increase in the area.

Table 3: Incremental rice production in the upper Dhaleswari basin due to reduction in flooding (RPT-NEDECO-BCL, 1989)

Rice Variety	**Rain fed/ Non-irrigated**			**Irrigated**		
	Area, ha	Yield increase, kg/ha	Incremental Production, ton	Area, ha	Yield increase, kg/ha[2]	Incremental Production, ton
Aus	25,160	90	2,264	2,900	200	580
B. Aman	19,150	35	670	3,040	75	228
T. Aman	6,800	95	646	6,611	100	1,058
HYV Aman	1,500	40[1]	60	5,964	225	1,342
Boro (local)	1,780	00[1]	00	-	-	-
Boro HYV	1,110	100[1]	111	14,740	225	3,317
Total			3,751			6,525

However, the early flood recession and overdrainage would result in lower yields in some areas depending on local conditions. The available soil moisture for non-irrigated Rabi crops would also decrease, affecting their yields. The availability of surface waters as well as the ground water development potential for irrigation in the upper Dhaleswari Basin would decrease.

Socio-Economic change:

The project has acquired about 2,350 ha of land affecting 2166 households. An estimated 13,089 project affected people (PAP) required resettlement. An estimated 1.4 million man-days employment in agriculture was lost due to acquisition of 1,156 ha of agricultural land for the project. However, 1.2 million additional man-days of employment ware created due to change in agricultural practices in the Dhaleswari basin. A total of 202 houses located within the right of way of the project ware moved to new locations. It was found that about 90% of the affected households lost more than 80% of their cropped land and hence their means of living.

A total of 1,033 boatmen were expected to be affected by the closure, but the affected people would get new job opportunities due to improved road communication. An estimated 9,000 professional and subsistence fishermen would be affected due to reduction in fish production in the Dhaleswai basin and spawn collection in the Jamuna river.

The Jamuna Multipurpose Bridge Authority (JMBA) took up the responsibilities of rehabilitation of displaced persons. The strategy for rehabilitation was drawn up, and a Resettlement Action Plan (RAP) was prepared (JMBA-RU, 1993). The displaced families were provided with a plot and appropriate training so that some of those farmers can find job outside the agricultural sector.

The bridge end facilities were converted into tourist spots and resorts after the construction of the bridge, which created opportunities for new employment. The construction of the bridge increased money supply and generated new economic and social structure in the project area. The land price increased, particularly the demand for the roadside plots was increased for industrial, commercial and settlement purposes. The bridge construction and following operation and maintenance created new job opportunities for skilled workers.

Pollution:

The construction of the bridge involved huge dredging of materials along river training works and along the bridge alignment. Dredging caused increased turbidity in the river water, which reduces light penetration, thereby interfering with the photosynthetic process affecting primary production and aquatic ecology of the river.

Dredging disturbs the top layer of oxidized sediments at the river bottom, expose and disturb the deeper anoxic layers. The removal as well as exposure of the anoxic material may result in high values for chemical and biochemical oxygen demand.

If present, dredging may mobilize toxic substances like hydrogen sulphide, methane, hydrocarbons, pesticides and heavy metals. However, testing of bottom sediments in few locations showed no toxic substance exceeding acceptable limit.

Other modes of pollution, such as noise and air pollution were expected during operation of dredgers, stationary machinery and moving river traffic. The impact from air and noise pollution resulting from dredging operations and traffic movement was deemed minimal due to open character of the landscape. Locally, it might have some effect on presence or movements of birds and aquatic life.

The traffic density in the area after the construction of the bridge was increased to cause traffic related pollution such as road surface runoff, noise, air pollution and spill of hazardous materials. The road surface runoff will pollute the road side areas with biodegradable substances and heavy metals. However, it is expected that during flood and rainy season the pollutants will be dispersed to concentrations lower than the acceptable levels in the environment.

The exhaust gases from cars, buses, trains, and trucks will cause atmospheric pollution. The pollutants in the exhaust will affect the quality of ambient air of the surrounding villages where people during pre-project time were living in non-polluted environment. In addition people in the neighborhood of the road will be exposed to high noise caused by the traffic. It is estimated that the noise level in the vicinity of the approach road will exceed the international standard level of 50 dB for outdoor residential areas.

It was estimated that about 1% of the total freight transport over the bridge would be hazardous which might cause pollution along the road by accidental spillage. Apart from this, urbanization and industrialization on both ends of the bridge will generate industrial and urban related pollution in the areas.

Environmental Costs and Benefits:

A summary of environmental cost and benefits of at 1993 price was estimated and presented in Table 4. The most significant benefit was the higher agricultural yields due to flood reduction during the monsoon period in areas affected by the closure of the north intake of Dhaleswari river. The additional benefit was derived from the protection of the flood embankments provided by the river training works. The annual benefits outweighed all environmental costs. However, the increased crop production estimated in the Dhaleswari basin during monsoon was based on optimistic assumptions. The change in agricultural practice by the farmers would be very slow and be gradually introduced through observation of reduced flooding in successive years.

Table 4: Summary of Environmental Cost and Benefits (Cost at 1993 price)

Parameters • **Impact Quantification**	**Nature of Impact**	**Cost–Benefit, MTaka/Year**
A. Agriculture		
• 1000 ton of additional rice produced change in cropping pattern in 57,000 ha of agricultural land	Positive	+50
• 1.2 Million man-days additional employment generation	Positive	+30
• 2,350 ha Land-loss to the Project (net)	Negative	–10
• 1.4 Million employment loss in agriculture	Negative	–35
B. Fisheries		
• Fish Reduction, 500 tons/year	Negative	–20
• 9,000 professional and subsistence fishermen affected	Negative	
C. Boat Navigation		–
• 21,200 tons of cargo	Negative	–4
• 60,000 Mand–days unemployment	Negative	–2
D. Erosion, Flood and drainage congestion	Negative	–6
E. Wildlife, Temporary displacement	Negative	–
F. Plantations		
• Loss of homestead trees	Negative	–
• Plantations	Positive	–
• 250,000 tons of fuel wood saving in North Western region due to gas transfer	Positive	–
G. Contraction related impacts, may be significant		–
Total		+3

3.0 CONCLUSIONS

The comprehensive Environmental Impact Assessment of a project including estimation of cost and benefits of major quantifiable environmental impacts is the first of its kind in Bangladesh. The environmental costs and benefits are dominated by positive impact on agriculture and negative impact on fisheries due to reduction of flooding in the Dhaleswari basin. The other negative impacts include discontinuation of boat navigation and transport of good using northern intake of Dhaleswari river, disruption navigation in upper Dhaleswari basin, destruction of homestead trees, erosion and drainage congestion, disruption of wildlife and environmental pollution during construction. Reclamation of land from Jamuna river, opportunities for fish culture in borrow pits, plantation at approach roads and bridge-end facilities and reduction of felling of trees for fuel wood due to transportation of gas in north-western region are some of the positive impacts. The quantifiable major negative impacts are compensated by positive impacts of the project but the net value of positive impacts can be greatly increased by reducing negative impacts and enhancement of positive impact through preparation and implementation of an effective Environmental Management Plan.

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